## **GEOLOGY**

## PHYSIOGRAPHIC REGION

The majority of the Nodaway River basin lies within the Western Glaciated Plains Natural Division with a small area near the mouth in the Big Rivers Upper Missouri Natural Division (Figure ND) (Thom and Wilson 1980). The entire basin is in the Dissected Till Plains (MDNR 1986a). The basin topography consists of rolling to hilly glacial plains divided by wide, level stream valleys. In the Iowa portion of the basin, most divides are rounded and parallel to the regional northeast-southwest drainage. Steep irregular loess mounds, formed from wind blown glacial outwash, border the Missouri River flood plain near the mouth of the Nodaway River.

## **GEOLOGY AND SOILS**

The basin soils overlay Cretaceous and Pennsylvanian deposited sedimentary bedrocks (Figure GE). The Pennsylvanian-aged formations consist primarily of sandstone, shale, limestone and thin seams of coal (USDA 1981).

Most basin soils are formed from glacial till (a mixture of clay, rock, gravel and sand), alluvium (water deposited soil), and a windblown silt called loess. The soils have their origin in the four periods of continental glaciation with deposits from the final glacial advance (Kansan) overlying earlier deposits. The topography of this region is the youngest in the state of Missouri. When glaciation ceased, the area was covered with a relatively level drift plain. After the last glaciation a thick layer of loess was deposited over the basin. Loess deposits in the basin are some of the deepest in Missouri, ranging from 10 - 30 feet in depth. The depth of the till is highly variable, but it generally ranges between 200 and 400 feet, obscuring most of the bedrock in the region. Occasional pockets or channels of sand are found in the till strata. Glacial sand and gravel may underlie the till (USDA-SCS 1982).

Loess soils cover broad, gently sloping ridges of silty loam and are suitable for farming. Glacial soil occurs on steeper, eroding slopes and it is a less productive brown loam or gritty silt loam. Valleys are covered with alluvial silt and clay loams, and are the most productive soils in the basin (USDA-SCS 1982).

### WATERSHED AREA

The Nodaway River is a sixth order river with a basin area of 1,820 square miles. The basin covers portions of southwestern Iowa and northwestern Missouri, with 1,230 square miles (68%) in Iowa and 590 square miles (32%) in Missouri. The Nodaway River basin is bound by the Platte River basin to the east and the Grand River and Des Moines River basins to the northeast, with the latter defining the boundary between the Missouri River and Mississippi River basins. The west side is bound by the Tarkio River basin, the northwest by the Nishnabotna River basin, and minor Missouri River tributaries to the southwest. The basin is about 115 miles in length. It averages 12 miles in width in the lower two-thirds and has a maximum width of 35 miles near the upper end. The flood plain width varies between one-half and two and one-half miles. The Nodaway River basin is prone to extensive flooding due to poor land use practices and its tapered top heavy shape (USCOE 1973).

## **CHANNEL GRADIENT**

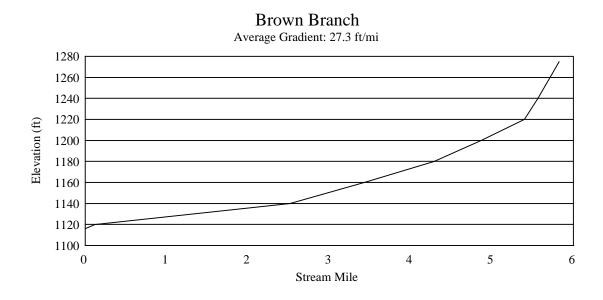
There are 156 third order and larger streams within the basin. Gradient information was calculated using USGS 7.5 minute topographic maps. Gradient information for all streams fourth order and larger are found in Appendix A. The Nodaway River was described as a low gradient river with a gradient of two to six feet per mile (USCOE 1973). Current gradient plots including the three main branches (East, Middle, and West Nodaway rivers) in Iowa range from 2.0 to 6.2 feet per mile indicating there has probably been little change in gradient over the past 25 to 30 years. Gradient in the lower 64 miles of the Nodaway River (confluence of the East and West Nodaway rivers to the confluence with the Missouri River) is virtually constant at 2.0 feet per mile. Average gradient values for fifth order streams range from 5.5 to 16.9 feet per mile. Fourth order stream gradients range from 7.6 to 45.0 feet per mile. As a general rule, shorter streams have higher average gradients.

## Arapahoe Creek Average Gradient: 16.9 ft/mi

1050 1000 950 850 800 0 2 4 6 8 10 12 14

Appendix A. Gradient plot for Arapahoe Creek, a 5th order tributary of the Nodaway River in the Nodaway River watershed. The location of the mouth is at Township 61, Range 36 and Section 31. The stream is located on 7.5 minute quadrangle maps New Point, Fillmore, and Bolckow NW.

Stream Mile

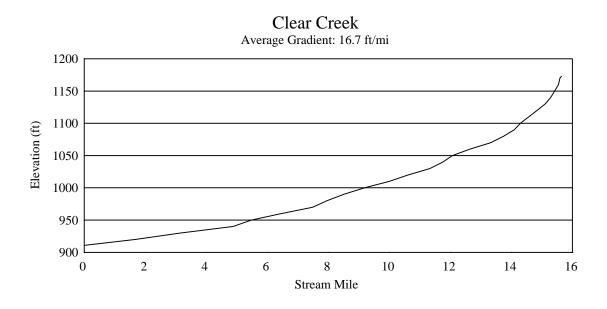


Appendix A. Gradient plot for Brown Branch, a 4th order tributary of the East Nodaway River in the Nodaway River watershed. The location of the mouth is at Township 72, Range 33 and Section 29. The stream is located on 7.5 minute quadrangle map Corning North.

## Average Gradient: 18.0 ft/mi Elevation (ft) Stream Mile

**Buchanan Creek** 

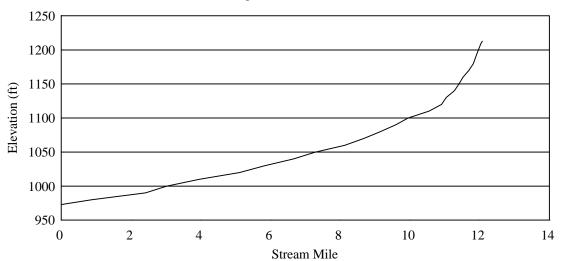
Appendix A. Gradient plot for Buchanan Creek, a 4th order tributary of the Nodaway River in the Nodaway River watershed. The location of the mouth is at Township 67, Range 36 and Section 19. The stream is located on 7.5 minute quadrangle maps Clearmont, Hopkins SW, and New Market.



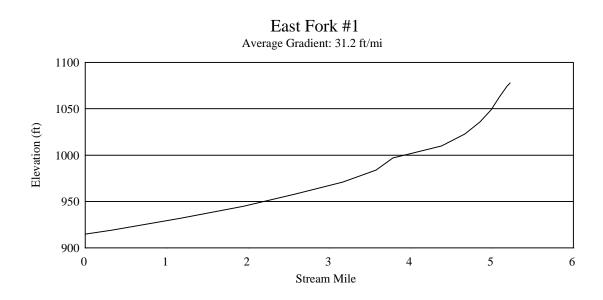
Appendix A. Gradient plot for Clear Creek, a 5th order tributary of the Nodaway River in the Nodaway River watershed. The location of the mouth is at Township 66, Range 37 and Section 27. The stream is located on 7.5 minute quadrangle maps Burlington Junction, Clearmont, Wilcox and Hopkins SW.

## Ditch Number 10 (Neele Branch)

Average Gradient: 19.9 ft/mi



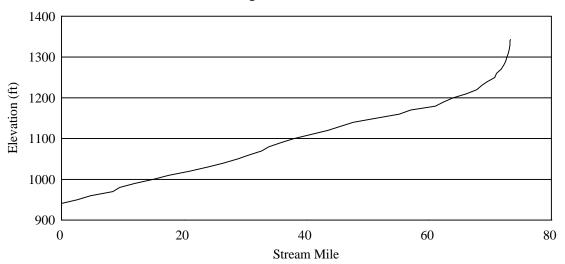
Appendix A. Gradient plot for Ditch Number 10 (Neele Branch), a 4th order tributary of the West Nodaway River in the Nodaway River watershed. The location of the mouth is at Township 69, Range 36 and Section 16. The stream is located on 7.5 minute quadrangle maps Hawleyville, Clarinda North, and Stanton.



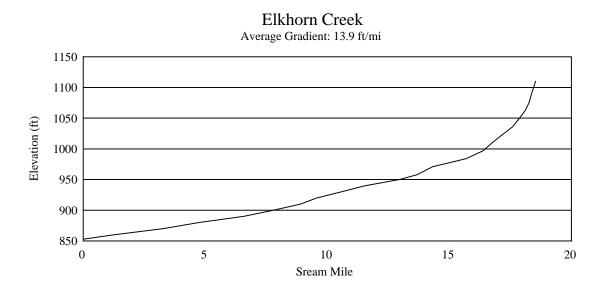
Appendix A. Gradient plot for East Fork Number 1, a 4th order tributary of Jenkins Creek in the Nodaway River watershed. The location of the mouth is at Township 62, Range 36 and Section 8. The stream is located on 7.5 minute quadrangle map Bolckow NW.

## East Nodaway River

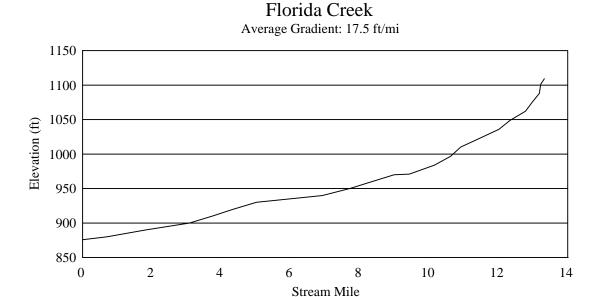
Average Gradient: 5.5 ft/mi



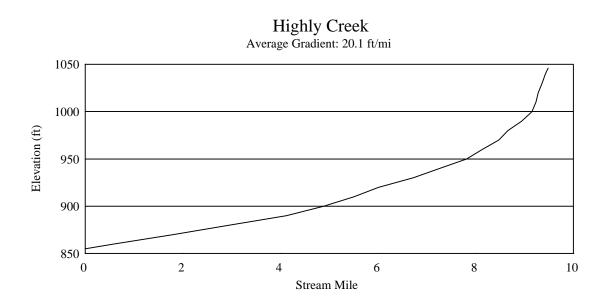
Appendix A. Gradient plot for East Nodaway River, a 5th order tributary of the Nodaway River in the Nodaway River watershed. The location of the mouth is at Township 67, Range 36 and Section 07. The stream is located on 7.5 minute quadrangle maps Clarinda South, New Market, Hawleyville, Villisca, Brooks, Corning South, Corning North, Prescott, Nevinville, and Orient.



Appendix A. Gradient plot for Elkhorn Creek, a 4th order tributary of the Nodaway River in the Nodaway River watershed. The location of the mouth is at Township 62, Range 37 and Section 22. The stream is located on 7.5 minute quadrangle maps Maitland, Skidmore, and Maryville West.



Appendix A. Gradient plot for Florida Creek, a 4th order tributary of the Nodaway River in the Nodaway River watershed. The location of the mouth is at Township 64, Range 37 and Section 33. The stream is located on 7.5 minute quadrangle maps Skidmore, Maryville West, and Wilcox.



Appendix A. Gradient plot for Highly Creek, a 4th order tributary of the Nodaway River in the Nodaway River watershed. The location of the mouth is at Township 62, Range 37 and Section 16. The stream is located on 7.5 minute quadrangle maps Maitland and Mound City.

## Average Gradient: 37.7 ft/mi 1100 1050 1000 950 900 850

Hagey Branch

Appendix A. Gradient plot for Hagey Branch, a 3th order tributary of the Nodaway River in the Nodaway River watershed. The location of the mouth is at Township 65, Range 37 and Section 29. The stream is located on 7.5 minute quadrangle maps Burlington Junction and Skidmore NW.

2

3

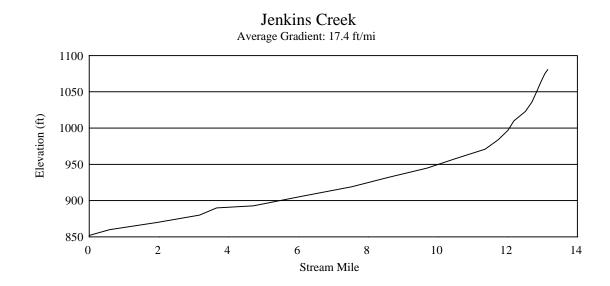
Stream Mile

4

5

1

0

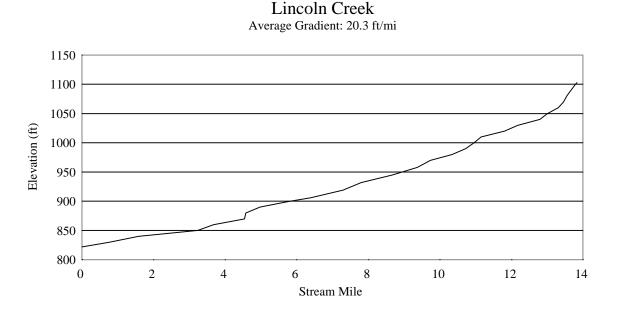


Appendix A. Gradient plot for Jenkins Creek, a 4th order tributary of the Nodaway River in the Nodaway River watershed. The location of the mouth is at Township 62, Range 37 and Section 22. The stream is located on 7.5 minute quadrangle maps Maitland, Bolckow NW, and Maryville West.

# Average Gradient: 11.7 ft/mi 1300 1250 1200 1150 1100 1050 0 5 10 15 20 25 Stream Mile

Kemp Creek

Appendix A. Gradient plot for Kemp Creek, a 4th order tributary of the East Nodaway River in the Nodaway River watershed. The location of the mouth is at Township 71, Range 35 and Section 11. The stream is located on 7.5 minute quadrangle maps Brooks, Carbon, Corning North, Prescott, and Nevinville.



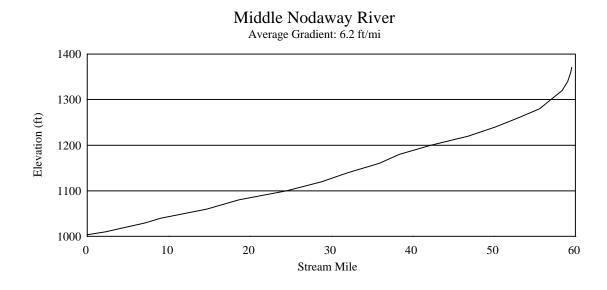
Appendix A. Gradient plot for Lincoln Creek, a 4th order tributary of the Nodaway River in the Nodaway River watershed. The location of the mouth is at Township 60, Range 37 and Section 25. The stream is located on 7.5 minute quadrangle maps Forbes, Amazonia, and Fillmore.

## Average Gradient: 24.4 ft/mi 1250 1200 1150 1050 1000 0 2 4 6 8 10

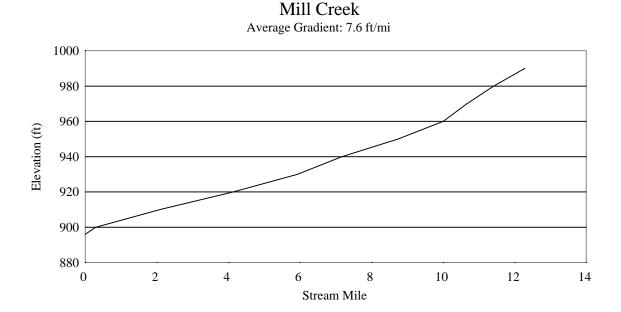
Stream Mile

Long Branch

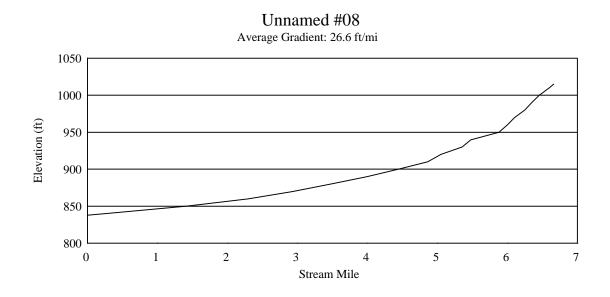
Appendix A. Gradient plot for Long Branch, a 4th order tributary of the East Nodaway River in the Nodaway River watershed. The location of the mouth is at Township 70, Range 35 and Section 17. The stream is located on 7.5 minute quadrangle maps Hawleyville, Villisca, and Brooks.



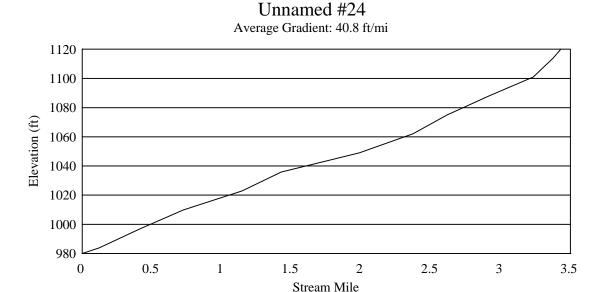
Appendix A. Gradient plot for Middle Nodaway River, a 5th order tributary of the West Nodaway River in the Nodaway River watershed. The location of the mouth is at Township 70, Range 36 and Section 33. The stream is located on 7.5 minute quadrangle maps Villisca, Morton Mills, Carbon, Corning North, Bridgewater, Nevinville, Fontanelle, Greenfield, and Canby.



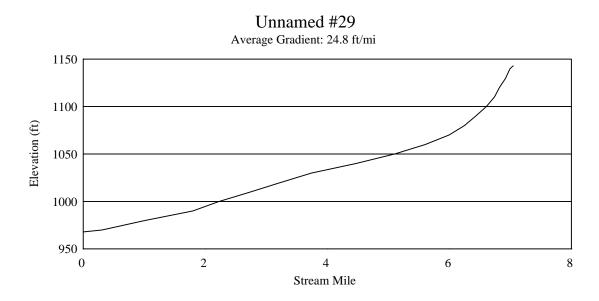
Appendix A. Gradient plot for Mill Creek, a 4th order tributary of the Nodaway River in the Nodaway River watershed. The location of the mouth is at Township 65, Range 37 and Section 17. The stream is located on 7.5 minute quadrangle maps Burlington Junction, Clearmont, and Blanchard.



Appendix A. Gradient plot for Unnamed stream number 8, a 4th order tributary of Nodaway River in the Nodaway River watershed. The location of the mouth is at Township 61, Range 37 and Section 27. The stream is located on 7.5 minute quadrangle maps New Point, and Fillmore.

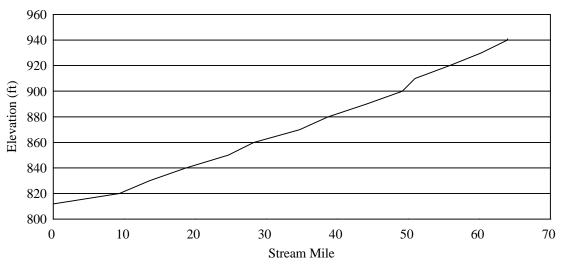


Appendix A. Gradient plot for Unnamed stream number 24, a 4th order tributary of South Fork Clear Creek in the Nodaway River watershed. The location of the mouth is at Township 65, Range 36 and Section 17. The stream is located on 7.5 minute quadrangle map Wilcox.

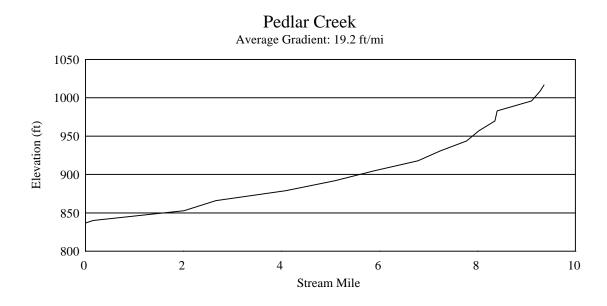


Appendix A. Gradient plot for Unnamed stream number 29, a 4th order tributary of Clear Creek in the Nodaway River watershed. The location of the mouth is at Township 66, Range 36 and Section 22. The stream is located on 7.5 minute quadrangle map Hopkins SW.

## Nodaway River Average Gradient: 2.0 ft/mi



Appendix A. Gradient plot for the Nodaway River, a 6th order tributary of the Missouri River. The location of the mouth is at Township 59, Range 36 and Section 29. The stream is located on 7.5 minute quadrangle maps Amazonia, Forbes, New Point, Maitland, Skidmore, Burlington Junction, Clearmont, and Clarinda South.

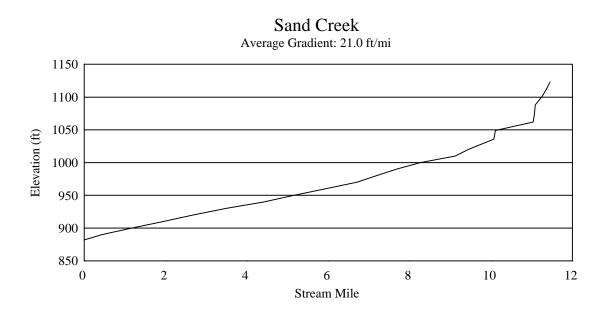


Appendix A. Gradient plot for Pedlar Creek, a 4th order tributary of Arapahoe Creek in the Nodaway River watershed. The location of the mouth is at Township 61, Range 36 and Section 30. The stream is located on 7.5 minute quadrangle maps New Point, Fillmore, and Bolckow.

## Average Gradient: 22.4 ft/mi 1400 1350 1300 1250 1200 1150 0 2 4 6 8 10 12 Stream Mile

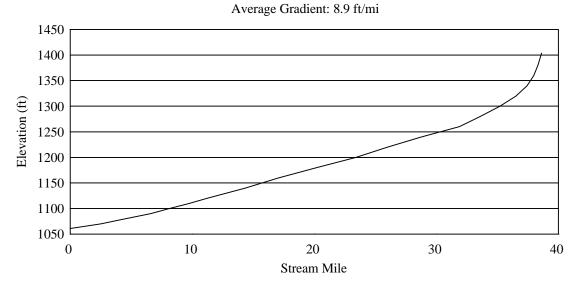
Rutt Branch

Appendix A. Gradient plot for Rutt Branch, a 4th order tributary of West Fork of the Middle Nodaway River, in the Nodaway River watershed. The location of the mouth is at Township 75, Range 33 and Section 15. The stream is located on 7.5 minute quadrangle maps Fontanelle SW, Fontanelle, and Canby.

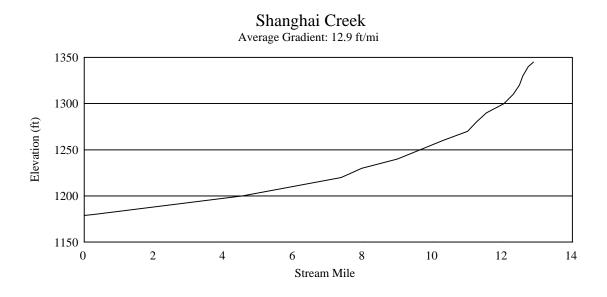


Appendix A. Gradient plot for Sand Creek, a 4th order tributary of the Nodaway River in the Nodaway River watershed. The location of the mouth is at Township 64, Range 37 and Section 21. The stream is located on 7.5 minute quadrangle maps Skidmore, Burlington Junction, and Wilcox.

## Sevenmile Creek

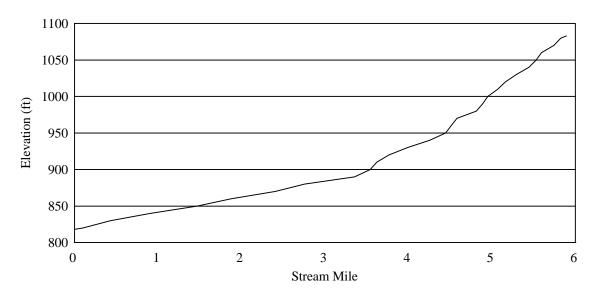


Appendix A. Gradient plot for Sevenmile Creek, a 4th order tributary of the West Nodaway River in the Nodaway River watershed. The location of the mouth is at Township 73, Range 36 and Section 33. The stream is located on 7.5 minute quadrangle maps Morton Mills, Wallin, Griswold NE, Lewis, Anita SW, Grant, Massena, Fontanelle SW, and Adair South.

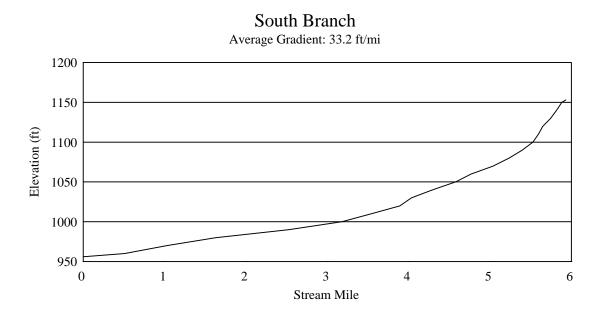


Appendix A. Gradient plot for Shanghai Creek, a 4th order tributary of East Nodaway River in the Nodaway River watershed. The location of the mouth is at Township 73, Range 32 and Section 16. The stream is located on 7.5 minute quadrangle maps Prescott, Nevinville, and Orient.

## Smith Creek Average Gradient: 45.0 ft/mi



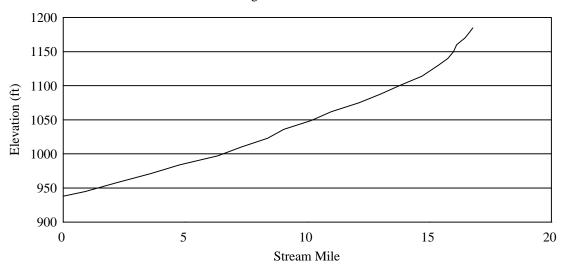
Appendix A. Gradient plot for Smith Creek, a 4th order tributary of the Nodaway River in the Nodaway River watershed. The location of the mouth is at Township 59, Range 36 and Section 07. The stream is located on 7.5 minute quadrangle maps Amazonia, and Forbes.



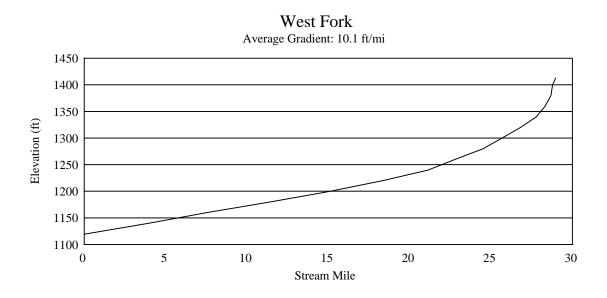
Appendix A. Gradient plot for South Branch, a 4th order tributary of the West Nodaway River in the Nodaway River watershed. The location of the mouth is at Township 68, Range 36 and Section 18. The stream is located on 7.5 minute quadrangle map Clarinda South.

## South Fork Clear Creek

Average Gradient: 14.7 ft/mi



Appendix A. Gradient plot for South Fork Clear Creek, a 4th order tributary of Clear Creek in the Nodaway River watershed. The location of the mouth is at Township 66, Range 36 and Section 29. The stream is located on 7.5 minute quadrangle maps Wilcox, and Hopkins SW.

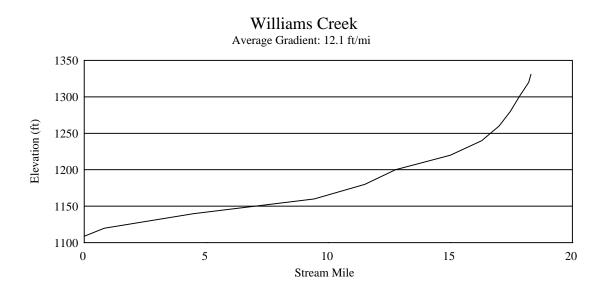


Appendix A. Gradient plot for West Fork, a 5th order tributary of the Middle Nodaway River in the Nodaway River watershed. The location of the mouth is at Township 74, Range 33 and Section 33. The stream is located on 7.5 minute quadrangle maps Bridgewater, Fontanelle SW, Adair South, and Canby.

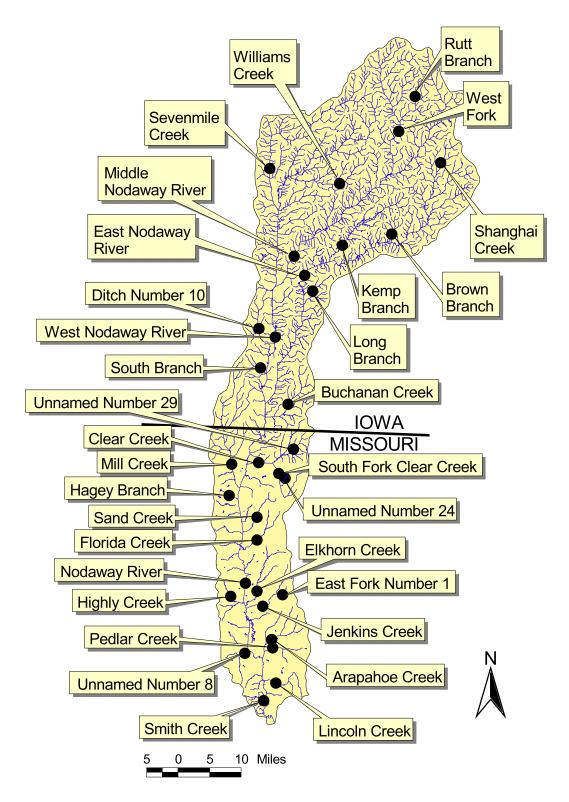
## West Nodaway River Average Gradient: 5.6 ft/mi 1400 1300 1200 1000 1000 900 0 20 40 60 80

Stream Mile

Appendix A. Gradient plot for West Nodaway River, a 6th order tributary of the Nodaway River in the Nodaway River watershed. The location of the mouth is at Township 67, Range 36 and Section 07. The stream is located on 7.5 minute quadrangle maps Clarinda South, Clarinda North, Hawleyville, Stanton, Villisca, Morton Mills, Grant, Dewey, Massena, Bridgewater, and Fontanelle SW.



Appendix A. Gradient plot for Williams Creek, a 4th order tributary of the West Nodaway River in the Nodaway River watershed. The location of the mouth is at Township 74, Range 36 and Section 35. The stream is located on 7.5 minute quadrangle maps Grant, Dewey, and Bridgewater.



Appendix A. Location of streams for which the gradient plots were generated. Gradient plots for 4th order and larger streams within the Nodaway River watershed, digitized from 7.5 minute series, 1:24000 scale, USGS topographic maps. Maps are on the following pages.

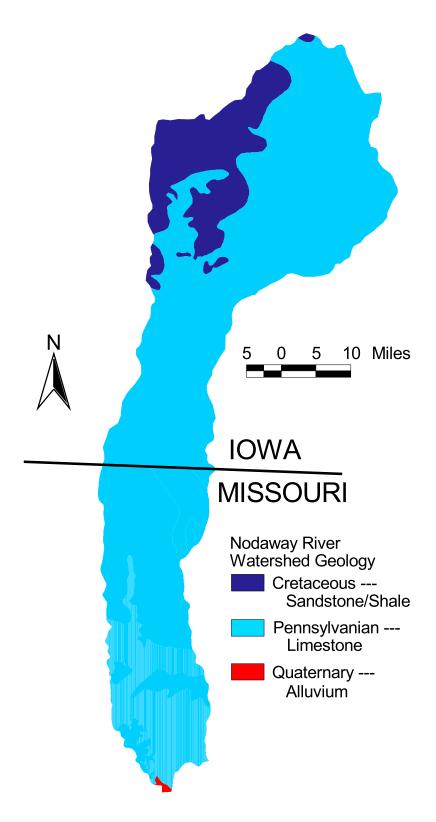


Figure GE. Geology in the Nodaway River watershed in Missouri and Iowa.

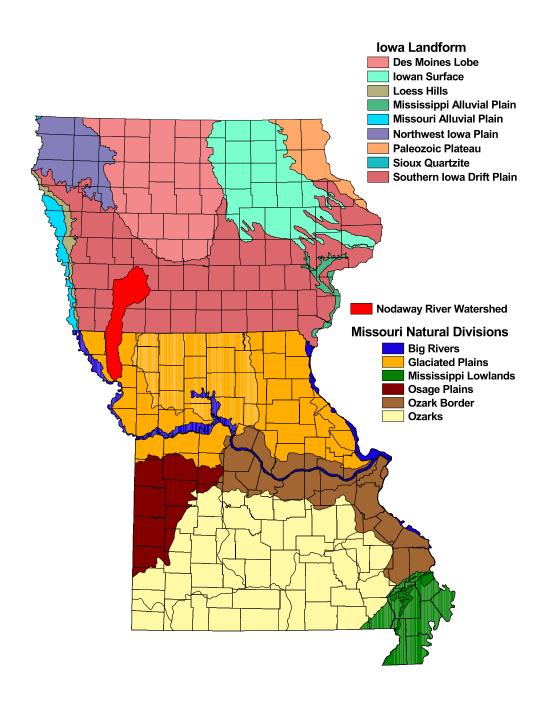


Figure ND. Location of the Nodaway River watershed within the natural divisions of Missouri and the landforms of Iowa.